Occupational Lead Exposure: Information for Physicians

OCCUPATIONAL HEALTH & SAFETY

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This publication reviews occupational lead exposure and the associated health effects. It also recommends steps to take when a patient has occupational exposure to lead, including methods to monitor the individual's exposure.

Reason for Concern

Lead exposure is associated with a variety of health problems including anemia, colic, constipation, peripheral neuropathy, nephropathy, arthralgias, loss of libido and impotence. Hypertension, gout, and chronic encephalopathy have also been associated with chronic lead exposure.

A Lower Acceptable Level of Lead Exposure

While widespread efforts are being made to minimize the use of lead in materials and improve workplace controls, there is a heightened concern about health effects from lower levels of lead exposure. The acceptable workplace air concentration (eight hour time-weighted average) for lead has been lowered to reflect concerns about low level lead exposure.

The acceptable eight-hour "Contamination Limit" for lead has been lowered from 0.15 mg/m^3 to 0.05 mg/m^3." Contamination Limits" are air concentrations that are not to be exceeded in work areas. See Section 307 and Table 21 of the Occupational Health and Safety Regulations, 1996, for more information.

Sources of Lead Exposure

In Saskatchewan, occupational lead exposure primarily occurs in:

- Radiator repair
- Gold ore extraction
- Construction (demolition)
- Foundry or other metal manufacturing work
- The aviation industry where leaded gasoline is still used

Lead exposure is also associated with processes such as:

- battery manufacturing or disposal
- making pottery
- working in firing ranges
- soldering lead alloys (e.g. electronic circuit boards)
- welding or grinding surfaces with lead-containing coatings.

Worker exposure occurs mainly by:

- Inhaling lead fumes produced from heating lead alloys or other lead-containing materials (e.g. when soldering radiators, thermal cutting lead-containing coatings).
- Inhaling airborne lead dust previously settled in the workplace (e.g. during a clean-up of a shooting gallery).
- Inhaling lead dust when cutting, grinding or buffing materials containing lead.
- Swallowing or ingesting lead particles or dust settled on hands, lips, facial hair, food or tobacco products.

Absorption and Health Effects

While lead can be absorbed through both the respiratory and gastrointestinal (GI) systems, it is much more readily absorbed through the respiratory system. However, lead ingestion should not be overlooked when assessing routes of occupational exposure. This route of exposure is often not recognized or addressed in the workplace. As a result ingestion can be a significant route of exposure.

In adults about 10 per cent of ingested lead is absorbed. Conditions such as fasting or deficiencies in calcium, phosphorous, iron or zinc can enhance GI lead absorption significantly. It is important to note that children absorb lead from the GI tract more readily than adults do.

While skin absorption of *inorganic* lead is negligible, skin absorption of *organic* lead compounds occurs readily. For example, tetra-ethyl lead is an organic form of lead in fuel for piston engine airplanes. It can be readily absorbed into the body via skin absorption.

Once absorbed by the body, lead is primarily bound to erythrocytes, but a plasma fraction is distributed extensively to tissues. This distribution of lead can result in high concentrations in bone, liver, lungs, kidney, spleen and teeth.[1] Lead accumulates in bone tissues where it substitutes for calcium. Although bone does not appear to be adversely affected, it can become a reservoir and a source of ongoing exposure to lead. Lead is released from bone into the blood stream even after workplace exposure has ceased. Conditions that promote bone turnover, also increase the release of lead from the bone. Approximately 90 per cent of the body burden of lead is bound to bone[1].

The half life of lead is approximately:

- **35 days in the blood, and**
- **25 to 30 years in bone.**

[1] See References

Severe cases of acute lead poisoning are rare in Canada. Acute poisoning from brief high exposures causes anemia, abdominal colic, constipation, fatigue and central nervous system dysfunction. Severe cases of acute exposure can result in encephalopathy, coma, seizures or death.

Chronic effects are insidious and include anemia, arthralgias, headache, weakness, depression, loss of libido, impotence, non-specific GI effects, chronic renal failure, hypertension, gout and chronic encephalopathy[1]. Lead is considered a hematologic, neurologic, renal and reproductive toxin.[1,2,3] See Figure 1 for an example of blood lead levels and their effects.

Recognizing Lead Exposure and Poisoning

The diagnosis of lead exposure and poisoning requires clues from a detailed history and a high degree of suspicion. A history should include focused questions on specific occupational or environmental sources of lead exposure.

Since the signs and symptoms of lead exposure are often nonspecific, the opportunity for misdiagnosis exists. Lead exposure in otherwise asymptomatic workers can also be found by blood test screening of workers with known exposure to lead.

While a general physical examination will help rule out other conditions, with respect to lead poisoning, particular attention should be directed to characteristic neurological and hematological abnormalities.

A physical examination should look for:

- Pallor (anemia)
- Blue gray pigmentation of the gums, commonly known as lead lines, due to lead deposition, and
- Motor weakness of the extremities, referred to as foot or wrist drop, due to peripheral neuropathy
- Signs of hypertension

Use of Particulate Respirators

Many workers in lead industries wear disposable or reusable particulate respirators. Appropriate respirators or respirator cartridges are approved by the National Institute for Occupational Safety and Health (NIOSH). The cartridge or disposable respirator should have a label indicating it is NIOSH-approved and have one of the following approval numbers: *P100, R100 or N100*. Pulmonary status should be evaluated in workers who wear respiratory protective devices.

Monitoring Blood for Lead Exposure

At present the blood lead level (BLL) is the single best indicator of recent exposure and acute elevation. The BLL provides good information on recent exposure, regardless of whether or not symptoms are present. The BLL will rise rapidly within hours of exposure and can remain elevated for weeks since the half life in blood is approximately 35 days.

Zinc protoporphyrin (ZPP) can also be measured in blood and reflects the toxic effects of lead on the erythrocytic enzyme ferrochelatase. The ZPP rises more slowly than the BLL and usually begins to rise once BLL reaches 1.45 to 1.95 µmol per litre (L). Once elevated, ZPP remains elevated for several months, and remains elevated long after blood levels have fallen. Combining a ZPP with a BLL can give clues to exposure time frames. For instance, an elevated BLL with normal ZPP would be suggestive of acute exposure, and an elevated ZPP with normal BLL would suggest past exposure, assuming other causes of elevated ZPP are ruled out.

Other useful laboratory tests in the investigation of lead exposure include a complete blood count (CBC), peripheral smear, creatinine/blood urea nitrogen (BUN), urinalysis, and any other investigations based on clinical judgment and concerns about specific end organ toxicity.

More recently, x-ray fluorescence has become a non-invasive way to determine body burden of lead, although this technique is not readily available in Saskatchewan.

Responding to Cases of Occupational Lead Exposure

Occupational Health and Safety can be contacted (Director Health Services) when you are treating a patient with an elevated blood lead level or other signs of occupational lead exposure. OHS specialists (toxicologists, hygienists) can provide technical assistance to the workplace to identify and control sources of lead exposure in a manner that respects patient confidentiality concerns.

A. If a worker's BLL is 1.5 µmol/L or greater, but less than 2.0 µmol/L:

- corrective action should be taken at the place of employment to reduce that worker's exposure. This might include better engineering controls (e.g. local exhaust ventilation), administrative and work practice controls to reduce exposure, and use of personal protective equipment. A thorough review of all these protective measures should be undertaken.
- The BLL should be rechecked 2 months after corrective actions at the workplace have begun.

B. If a worker's BLL is 2.0 µmol/L, but less than 2.4 µmol/L:

- the worker's exposure to lead or work with lead materials should be *significantly and substantially* reduced **or** eliminated entirely. Removal from exposure may not necessarily mean complete removal from the workplace, as alternate work that does not involve any lead exposure may be available.
- the cessation or significant reduction of lead exposure should be continued until the BLL has returned to a level below 1.5 µmol/L.
- When the BLL has decreased to less than 1.5 µmol/L , the previous work tasks can be resumed, provided that significant changes have been made to reduce their exposure to lead (e.g. local exhaust ventilation).
- The BLL should be checked at least monthly until the BLL has returned to below 1.5 µmol/L.

C. If a worker's BLL is over 2.4 µmol/L:

- These levels should be confirmed immediately
- Contact OHS to ensure that the sources of lead exposure are addressed for all workers at the workplace.
- the worker's exposure to lead must be eliminated until the BLL returns to less than 2.0 µmol/L. At that time the worker can return to the workplace, if alternate work is available that has minimal or no lead exposure (See A for measures needed when the BLL is between 1.5 µmol/L and 2.0 µmol/L).
- The worker can resume their previous work tasks only after significant changes have been made to reduce their lead exposure (e.g. local exhaust ventilation) and their BLL is below 1.5 µmol/L.
- The BLL should be rechecked every 2-4 weeks

The use of chelation is not generally recommended in cases of long term lead exposure but may be considered in acute, high exposures.[1-3] The primary approach to managing cases of lead exposure is to reduce or eliminate further exposure. The decision to chelate is based on many factors including the lead level, current symptoms and signs, and duration of exposure. Physicians considering chelation are always advised to consult with colleagues experienced in the area.

Exposure As Low as Reasonably Achievable

Although 1.5 µmol/L is suggested as a starting point to initiate corrective action, there is mounting evidence in the literature that lead can cause physiological effects at very low levels. It is recommended that, notwithstanding the above recommendations, exposure to lead and lead materials should be kept as low as reasonably achievable at all times. Furthermore, when non-lead materials can be substituted for lead materials, this should always be done.

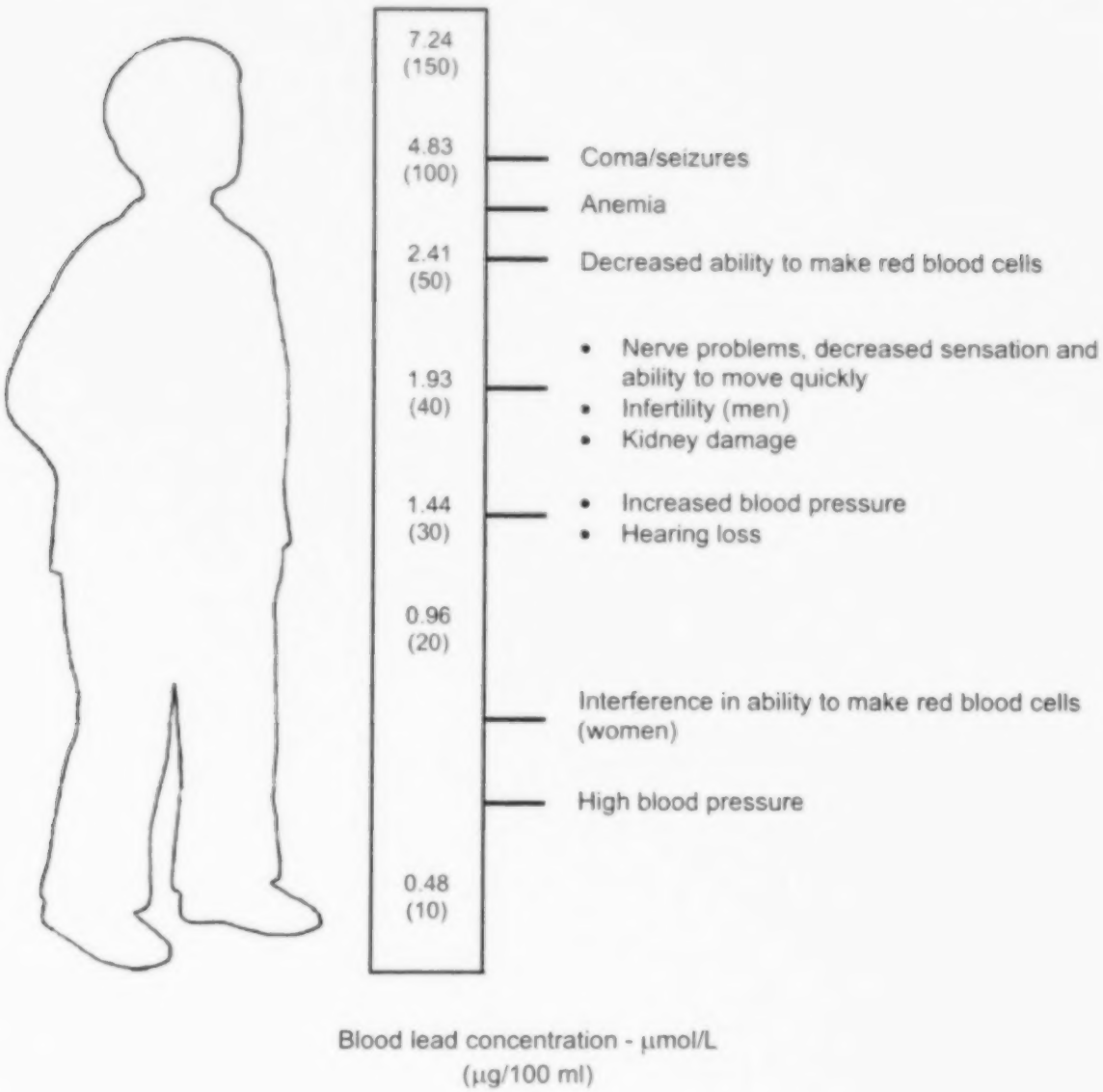
Clinical Judgment

While the above parameters are a guideline, test results are never a substitute for clinical judgment. Considerable variability between individuals can be expected with respect to symptoms at a given blood lead level. The worker with an elevated lead level should always be evaluated medically to determine if any symptoms are present.

The Chief Occupational Medical Officer for Occupational Health and Safety can also be used in such cases. Phone (306) 966-8286.

Figure 1

Blood lead levels and their effects.



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